

# Doppler Wind and Temperature Sounder: IR Limb Emission Sensor Development

Completed Technology Project (2018 - 2021)



## Project Introduction

**Key Objectives:** We propose to develop and test, in the laboratory and from a balloon platform, a prototype limb emission sensor that will eventually be the basis for a space based high altitude temperature and wind sounder referred to as DWTS (Doppler Wind and Temperature Sounder). The goal of the proposed work is to further the development of this sensor and to verify in-orbit calibration procedures by flying it on a high altitude balloon. This will bring the DWTS technology to a high TRL level in preparation for orbital operations. **Objective Details:** The project objectives are to 1. Build a prototype DWTS instrument, 2. Demonstrate the required performance of the critical subsystems in the laboratory, then 3. Further demonstrate the performance on a number of high altitude balloon flights that will exercise the in-orbit calibration procedures. Most critical of these is the calibration and removal of stray light for which we will demonstrate the efficacy of on-board procedures using the sun and moon as natural calibration sources. GATS Inc. of Newport News, VA will lead instrument design, development and construction through contracts to LASP of Boulder, CO and Brandywine Photonics of Exton, PA. Instrument testing will produce detailed characterization of the instrument, including, but not limited to, absolute pixel response, spectral response, stray light, pixel flat fielding, and response to thermal changes. We will also develop and demonstrate an on-board data processing system required for an orbiting DWTS instrument. Virginia Tech of Blacksburg, VA will perform integration and operation of the balloon flights. This work will also be part of a small satellite initiative designed to train Virginia Tech students in space mission technology. All DWTS sensor components are commercial-off-the-shelf, or minor modification of COTS components. **Significance:** DWTS is a very simple system composed of one or more channels, with each channel comprised of an IR camera and spectral filtering provided by a gas cell along with a broadband filter. By using a novel implementation of gas filter correlation radiometry (GFCR), this simple, small, static, inexpensive IR camera can measure the Doppler broadening and shift of thermal emission spectra, allowing the simultaneous inference of wind and temperature from lower mid stratosphere to over 200 kilometers, continuously, day and night, every 10 kilometers along-track. DWTS could revolutionize global monitoring of upper altitude winds and temperature. Therefore, the data provided by such a system directly addresses ITM science. Beyond the ITM, data from a constellation of DWTS sensors could provide the next leap in both long-term surface weather forecasting and space weather "now casting", by supplying global coverage of high altitude temperature and winds at unprecedented accuracy and spatial resolution. In addition, the instruments will provide a wealth of thermosphere research data, including the extension of temperature and nitric oxide emission products now being supplied by the SABER instrument on the aging HSO TIMED mission. DWTS measurements would directly address the NASA Heliophysics STP program goal of understanding the dynamical coupling between lower and upper atmosphere. DWTS could supply data to understand these mechanisms



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## Organizational Responsibility

### Responsible Mission Directorate:

Science Mission Directorate (SMD)

### Responsible Program:

Heliophysics Technology and Instrument Development for Science

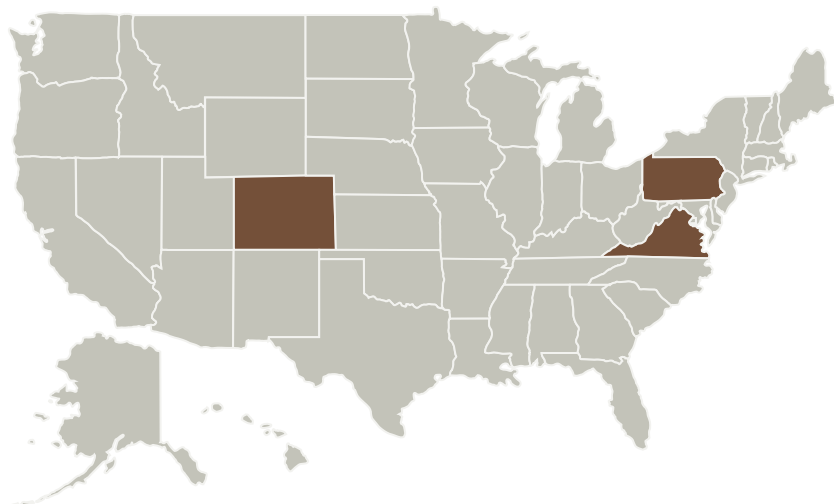
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continuously from lower stratosphere up to mesosphere and into the mid to upper thermosphere, and the goal of forecasting upper atmosphere weather.

## Primary U.S. Work Locations and Key Partners



## Project Management

### Program Director:

Roshanak Hakimzadeh

### Program Manager:

Roshanak Hakimzadeh

### Principal Investigator:

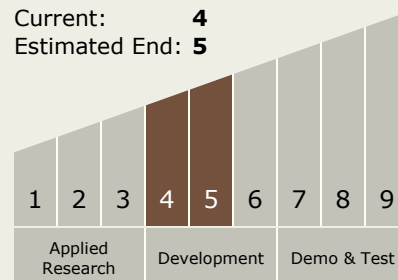
Larry L Gordley

### Co-Investigators:

Amal Chandran  
Benjamin T Marshall  
Scott M Bailey  
Della L Boscana  
Brentha Thurairajah  
John Fisher  
Justin Carstens

## Technology Maturity (TRL)

Start: 4  
Current: 4  
Estimated End: 5



## Technology Areas

### Primary:

- TX08 Sensors and Instruments
  - TX08.1 Remote Sensing Instruments/Sensors

*Continued on following page.*

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Organizations Performing Work	Role	Type	Location
Brandywine Photonics LLC	Supporting Organization	Industry	
GATS, Inc.	Supporting Organization	Industry	Newport News, Virginia
GLOBAL ATMOSPHERIC TECHNOLOGIES AND SCIENCES(GATS)	Supporting Organization	Industry	Newport News, Virginia
University of Colorado Boulder Laboratory for Atmospheric and Space Physics(LASP)	Supporting Organization	Academia	Boulder, Colorado
Virginia Polytechnic Institute and State University(VA Tech)	Supporting Organization	Academia Asian American Native American Pacific Islander (AANAPISI)	Blacksburg, Virginia

Technology Areas  
(cont.)

└ TX08.1.1 Detectors and Focal Planes

Target Destination  
The Sun

## Primary U.S. Work Locations

Colorado	Pennsylvania
Virginia	